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In re U.S. Patent Application of Tsutomu IKEDA et al.
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For: Rotational Angel Sensor And Method Manufacturing Same, And Throttle Control Device With Rotational Angle Sensor

VERIFICATION OF TRANSLATION

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Sir:

I, Shiho SAKAI work at OKADA PATENT & TRADEMARK OFFICE, P.C., Nagoya Chamber of Commerce & Industry Bldg., 10-19, Sakae 2-chome, Naka-ku, Nagoya-shi, Aichi-ken, Japan and declare that:

(1) I understand both Japanese and English;

(2) the attached English translation is a true and correct translation of Japanese Patent Application No. 2004-025553 filed February 2, 2004, which application corresponds to the above-identified application, to the best of my knowledge and belief; and

(3) all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 USC 1001, and that such false statements may jeopardize the validity of the application or any patent issuing thereon.

April 20, 2011 — Shiho Sakai

Date — Shiho SAKAI

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[List of Accompanying Documents]

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[Name of Document]	Abstract	1

[Name of Document] Specification
[Name of Invention] ROTATIONAL ANGLE SENSOR AND METHOD FOR MANUFACTURING SAME, AND THROTTLE CONTROL DEVICE WITH ROTATIONAL ANGLE SENSOR

[Technical Field of the Invention]

[0001]

The present invention relates to a rotational angle sensor and a method for manufacturing the same, and a throttle control device with a rotational angle sensor.

[Background of the Invention]

[0002]

Some electronically-control-type throttle control devices used for controlling an intake air flow into an engine of such as an automobile include rotational angle sensors serving as throttle sensors for detecting a rotational angle of a motor shaft of an electric motor, which drives a throttle valve (see Patent Document 1 for example).

Some rotational angle sensors used for these throttle control devices include magnetic detectors for detecting a rotational angle of a rotor based on a magnetic field generated between a pair of magnets respectively disposed across the rotational axis of the rotor, and a printed circuit board electrically connected with each connection terminal of the magnetic detectors (see Patent Document 2 for example).

[Patent Document 1] Japanese Laid-Open Patent Publication No. 6-264777

[Patent Document 2:] Japanese Laid-Open Patent Publication No. 2003-57071

[Summary of the Invention]

[Problems to be solved by the Invention]

[Disclosure of the Invention]

[0003]

According to the rotational angle sensors of the aforementioned Patent Document 2, the problem has been that using a printed circuit board, which is generally perceived as expensive, forces the cost to be increased.

[0004]

A problem to be solved by the present invention is to provide a rotational angle sensor and a method for manufacturing the same, and a throttle control device with a rotational angle sensor, which may lower the cost.

[Means for Solving Problems]

[0005]

The aforementioned problem can be solved by a rotational angle sensor and a method for manufacturing the same, and a throttle control device with a rotational angle sensor, within the gist of the constructions described in the claims.

According to the rotational angle sensor in claim 1, connection terminal of the magnetic detector for detecting a rotational angle of a rotor is directly connected to each terminal. Therefore, it is possible to lower the cost by using inexpensive terminals, comparing to expensive printed circuit boards that have conventionally been required.

[0006]

According to the rotational angle sensor in claim 2, constructing a sensor assembly, which forms the magnetic detector, the terminals and the holder member into an assembly, facilitates handling the magnetic detector and the terminals. Further, it is possible to reduce the size of the sensor assembly, because the structure is more simplified than in using a printed circuit board. Accordingly, it is possible to reduce the equipment expenses so as to lower the cost.

[0007]

According to the rotational angle sensor in claim 3, a potting material is potted into the holder member so as to cover the magnetic detector and the connection portions between connection terminals of the magnetic detector and the respective terminals.

Thus, it is possible to prevent the intrusion of moisture to the electrically conductive portions so as to prevent or reduce the occurrence of shunt or short and migration. Additionally, when the potting material has flexibility, it is possible to protect the magnetic detector from thermal stress, vibrations and the like. Additionally, since no excess pressure is applied to the magnetic detector when it is potted, it is possible to avoid characteristic changes of the magnetic detector caused by the pressure. For these reasons, it is possible to increase the reliability of the rotational angle sensor.

Further, when a printed circuit board is used, covering the printed circuit board requires plenty of potting material, but conversely, it is possible to cover the connection portions between connection terminals of the magnetic detector and the terminals with a smaller amount of the potting material such that the material cost for the potting material is lowered.

[0008]

According to the rotational angle sensor in claim 4, the capacitors as a preventive measure for discharge of positive charges are directly connected between the respective terminals and covered with the potting material. Thus, the potting material having flexibility

may protect the capacitors from thermal stress, vibrations and the like. Further, since no excess pressure is applied to the capacitors when they are potted, it is possible to avoid disconnection, destruction and the like of the capacitors caused by the pressure. Accordingly, it is possible to increase the reliability of the rotational angle sensor.

[0009]

Further, according to the rotational angle sensor as in claim 5, the capacitors are disposed in a plane on the same side as the connection side of the respective terminals connected with the magnetic detector. Thus, it is possible to facilitate disposing the magnetic detector and the capacitors with respect to the terminals.

[0010]

According to the rotational angle sensor in claim 6, a stationary body is provided, which is resin molded with the sensor assembly inserted. Thus, it is possible to easily form the stationary body having the sensor assembly.

[0011]

According to the rotational angle sensor in claim 7, the connection terminals of the magnetic detector and the terminals are connected by welding. Thus, since the strength of the connection between the connection terminals of the magnetic detector and the terminals is enhanced, it is possible to prevent or reduce disconnection caused by repeated temperature cycles.

[0012]

According to the method of the invention for manufacturing the rotational angle sensor in claim 8, press molding a sheet stock so as to form a terminal unit enables the terminals to be accurately formed. Further, connecting the connection terminals of the magnetic detector with the terminal unit enables the connection terminals of the magnetic detector to be accurately connected to the terminals. Further, removing the tie bars from the terminal unit enables theterminals to be easily formed separately. Therefore, the rotational angle sensor of the first invention can be reasonably manufactured.

[0013]

According to the throttle control device in claim 9, the throttle control device is constructed to include any one of the rotational angle sensors of claim 1 to claim 7 so as to detect opening degrees of the throttle valve. Thus, it is possible to provide a throttle control device that provides operations and effects similar to those of the rotational angle sensor defined in any one of claims 1 to 7.

[Advantageous Effect of Invention]

[0014]

According to the rotational angle sensor, the method for manufacturing the rotational angle sensor and the throttle control device with the rotational angle sensor, connection terminals of the magnetic detector detecting the rotational angle of the rotor are directly connected to terminals, and therefore, it is possible to lower the cost by using inexpensive terminals comparing to expensive printed circuit boards that have conventionally been required.

[Best Mode for Carrying Out the Invention]

[0015]

Referring now to embodiments, a best mode for carrying out the present invention will be described.

[First Embodiment]

[0016]

A first embodiment of the invention will be described based on FIG. 1. It should be noted that this embodiment illustrates a rotational angle sensor used as a throttle sensor for detecting a rotational angle of a throttle valve of a throttle shaft to which the throttle valve is attached.

[0017]

The throttle control device will firstly be described. As shown in FIG. 1, this throttle control device includes a throttle body 1 made of resin such as PBT. The throttle body 1 includes a bore wall portion 2 and a motor housing portion 3 that are integrated with each other. The bore wall portion 2 forms a substantially cylindrical intake air passageway 4, which passes orthogonal to the plane of the drawing as viewed in FIG. 1. Although not shown in the drawings, an air cleaner is connected to an upstream side of the bore wall portion 2 of the throttle body 1, while an intake manifold is connected to a downstream side of the bore wall portion 2.

[0018]

A metal throttle shaft 6, which extends across the intake air passageway 4 in the diametrical direction, is disposed in the bore wall portion 2. A support portion 7, which is integrally formed with the bore wall portion 2, rotatably supports one end 6a (the left end portion as viewed in FIG. 1) of the throttle shaft 6 via a bearing 8. Further, a support portion 9, which is integrally formed with the bore wall portion 2, rotatably supports the other end (the right end portion as viewed in FIG. 1) of the throttle shaft 6 via a bearing 10.

Further, a throttle valve 12, which can rotatably open and close the intake air passageway 4, is secured to the throttle shaft 6 via rivets 13. The throttle valve 12 controls an intake air flow flowing through the intake air passageway 4 by opening and closing the intake air passageway 4 when driven by a motor 20 (later described).

[0019]

The left-side support portion 7 is fitted with a plug 14 sealing the opening end thereof.

Further, the right end 6b of the throttle shaft 6 passes through the support portion 9. A throttle gear 16, which is configured as a sector gear, for example, made of resin, is rotationally locked to be secured to the right end 6b of the throttle shaft 6.

Further, a return spring 17 is provided between the throttle body 1 and the throttle gear 16. The return spring 17 constantly biases the throttle gear 16 in the closing direction of the throttle valve 12.

It should be noted that a stopper member, not shown in the drawings, is provided between the throttle body 1 and the throttle gear 16 so as to stop the throttle valve 12 at a predetermined closed position.

[0020]

The motor housing portion 3 of the throttle body 1 is formed as a substantially cylindrical, closed-end tube that extends parallel to the rotational axis L of the throttle shaft 6 and opens at the right end surface as viewed in FIG. 1. The motor 20 consisting of such as a DC motor is inserted into the motor housing portion 3. The shell of the motor 20 is formed by a motor case 21, which is provided with a mounting flange 22 secured by a screw 23 to the opened end of the motor housing portion 3.

[0021]

An output shaft 24, which projects to the right side of the motor 20 as viewed in FIG. 1, is provided with a motor pinion 26, for example, made of resin.

Further, the throttle body 1 is provided with a counter shaft 27 that extends parallel to the rotational axis L of the throttle shaft 6. The counter shaft 27 rotatably supports a counter gear 28, for example, made of resin. The counter gear 28 includes gears with different diameters, a larger one of which is a gear portion 28a and a smaller one a gear portion 28b. The larger-diameter gear portion 28a engages the motor pinion 26, while the smaller-diameter gear portion 28b engages the throttle gear 16.

It should be noted that the throttle gear 16, the motor pinion 26 and the counter gear 28 form a speed-reduction gear mechanism 29.

[0022]

One lateral surface (the right-side surface as viewed in FIG. 1) of the throttle body 1 is coupled with a cover 30, for example, made of resin such as PBT. The cover 30 covers the speed-reduction gear mechanism 29 and the like. Further, an O-ring 31 is interposed between the throttle body 1 and the cover 30 so as to maintain a hermetic seal of the inside.

Further, pin portions 32 project from the mating surface of the cover 30 against the throttle body 1. Further, the mating surface of the throttle body 1 against the cover 30 is provided with receiving portions 33, into which the pin portions 32 are engageable. When the pin portions 32 engage into the receiving portions 33, the throttle body 1 and the cover 30 are positioned in place.

It should be noted that the cover 30 is equivalent to the "stationary body" herein.

[0023]

The motor 20 includes two motor terminals 35 (only one of which is shown in FIG. 1), which are respectively connected with relay connectors 36 provided in the cover 30. One of the relay connectors 36, as viewed in FIG. 2, is connected with a connector connection end 37a of a first plate terminal 37, which is insert molded or inserted to be resin molded into the cover 30. Further, the other of the relay connectors 36 is connected with a connector connection end 38a of a second plate terminal 38, which is insert molded or inserted to be resin molded into the cover 30. It should be noted that an external connection end 37b, 38b of each plate terminal 37, 38 projects into a substantially horizontally rectangular cylinder shaped connector portion 40, which is formed in a predetermined portion (see, FIG. 4) of the cover 30 (see, FIG. 2).

Further, the connector portion 40 of the cover 30 is connectable with an unshown external connector. Further, the external connection ends 37b, 38b of the plate terminals 37, 38, and external connection ends 111b, 112b, 113b, 114b of the sensor terminals 111, 112, 113, 114 (later described), are connectable both with the external connector (not shown) for the connector portion 40 and with each terminal pin (not shown) within the external connector.

FIG. 16(a) is a front view showing the first plate terminal, while FIG. 16(b) is a side view showing the same. Further, FIG. 17(a) is a front view showing the second plate terminal, while FIG. 17(b) is a side view showing the same. Further, the outer surface of each plate terminal 37, 38 is plated with Ni (not shown).

[0024]

Referring to FIG. 1, the drive of the motor 20 is controlled by a control means such as an engine control unit, or the so-called ECU, of the automobile, in response to accelerator signals representing the amount of depression of an accelerator pedal, traction control signals,

constant-speed signals and idling speed control signals. Further, driving forces of the output shaft 24 of the motor 20 are transferred from the motor pinion 26 to the throttle shaft 6 via the counter gear 28 and the throttle gear 16 so as to open and close the throttle valve 12.

[0025]

The throttle gear 16 is provided with a substantially cylindrical tubular portion 16a. The tubular portion 16a is concentric with the throttle shaft 6 and projected toward the cover 30 beyond the end surface of the throttle shaft 6. With the inner peripheral surface of the tubular portion 16a, a yoke 43 made of a ring-shaped magnetic material substantially about the rotational axis L of the throttle shaft 6 is insertion-molded or is molded with resin by being inserted. It should be noted that the throttle gear 16 is equivalent to the "rotor" herein.

[0026]

The inner surface of the throttle gear 16 is provided with a pair of magnets 44, 45 generating magnetic fields. The magnets 44, 45 are disposed in line symmetry with the rotational axis L of the throttle shaft 6 such that the magnets 44, 45 and the yoke 43 are insert molded or inserted to be resin molded in the throttle gear 16. The pair of magnets 44, 45, which consist of such as ferrite magnets, are formed in arc shape along with the inner surface of the yoke 43 (see two-dot chain lines 44, 45 in FIG. 22).

Further, the pair of magnets 44, 45 are parallel magnetized such that the magnetic lines, or magnetic fields, generated between both are formed in a parallel relationship, and thereby substantially parallel magnetic fields are generated in the space defined within the yoke 43. It should be noted that the ferrite magnets forming the pair of magnets 44, 45 could be easily formed in arc shape because the ferrite magnets are softer and higher in toughness than rare-earth magnets, and also inexpensive because the material costs less.

[0027]

Then, as shown in FIG. 2, the relay connectors 36 and the plate terminals 37, 38, as well as a sensor terminal assembly 120 (later described), are insert molded or inserted to be resin molded into the cover 30.

Further, as shown in FIG. 14, the sensor terminal assembly 120 consists of the sensor assembly 100 and the sensor terminal unit 110.

Further, as shown in FIGS. 10(a), 10(b) and 10(c), the sensor assembly 100 consists of the terminal assembly 70 and the holder 90.

For convenience of description, the terminal assembly 70, the holder 90, the sensor assembly 100, the sensor terminal unit 110, the sensor terminal assembly 120 and the cover

30 will be described below in this order. It should be noted that the components of the sensor assembly 100 are shown in FIG. 11 in an exploded perspective view.

[0028]

Firstly, the terminal assembly 70 will be described. It should be noted that FIG. 8(a) is a side view showing the terminal assembly 70; and FIG. 8(b) is a rear view showing the same. As shown in FIGS. 8(a) and 8(b), the terminal assembly 70 consists of two sensor ICs 50(1), 50(2), one terminal unit 60 and four capacitors 81, 82, 83, 84 (see FIG. 11).

Two of the same sensor ICs 50 are used as the two sensor ICs 50(1), 50(2) (see, FIGS.6 (a) and 6(b)).

As shown in FIGS. 6(a) and 6(b), the sensor IC 50 includes a magnetic sensing portion 51 and a computing portion 52, which is arranged in the rear (the right side as viewed in FIGS. 6(a) and 6(b)) of the magnetic sensing portion 51. The magnetic sensing portion 51 is configured in a substantially square plate shape, while the computing portion 52 is configured in a substantially rectangular plate shape. The magnetic sensing portion 51 and the computing portion 52 are electrically connected with each other by, for example, six connecting terminals 53 (see FIG. 6(b)). The magnetic sensing portion 51 includes magnetoresistive elements embedded in a shell, for example, made of resin. Further, both the left and the right sides of the shell of the magnetic sensing portion 51 are provided with metal projecting pieces 54, which project symmetrically from both the left and right sides (see, FIG. 6(b)). When the sensor ICs 50 are injection molded, these projecting pieces 54 are retained in the die as positioning pieces of the magnetoresistive elements. Further, the computing portion 52 includes an input connection terminal 55, a ground connection terminal 56 and an output connection terminal 57 projecting parallel to each other and rearward (rightward as viewed in FIG. 6 (b)).

It should be noted that the sensor ICs 50 (a) and 50(b) are equivalent to the "magnetic detector" herein.

[0029]

As shown in FIG. 6(c), one of sensor ICs 50 is formed as a first sensor IC 50(1), the connecting terminals 53 of which are folded such that the magnetic sensing portion 51 is inclined toward the reverse side (upward as viewed in FIG. 6(c)) at an angle of approximately 90 degrees. Each connection terminal 55, 56, 57 of the first sensor IC 50(1) is folded toward the front side (downward as viewed in FIG. 8(c)) at an angle of approximately 90 degrees (see FIG. 11).

Further, as shown in FIG. 6(s), the other sensor IC 50 is formed as a second sensor IC 50(2), the connecting terminals 53 of which are folded such that the magnetic sensing portion 51 is inclined toward the front side (downward as viewed in FIG. 6(d)) at an angle of approximately 90 degrees. Each connection terminal 55, 56, 57 of the second sensor IC 50(2) is folded toward the reverse side (upward as viewed in FIG. 6(d)) at an angle of approximately 90 degrees (see FIG. 11).

[0030]

Then, the terminal unit 60 will be described. It should be noted that FIG. 7(a) is a perspective view showing the terminal unit 60; FIG. 7(b) is a side view showing the same; and FIG. 7(c) is a rear view showing the same.

The terminal unit 60 is formed by press molding an electrically conductive sheet stock such as a copper alloy plate. As shown in FIG. 7(c), the terminal unit 60 includes a signal input (Vc) terminal 61, a signal output (V1) terminal 62, a signal output (V2) terminal 63, and a ground (GND) terminal 64. Terminal connections 61a, 62a, 63a, 64a (later described) of the terminals 61, 62, 63, 64 are connected with each other by tie bars 65, 66, 67, 68, which form a substantially square frame-like shape.

In FIG. 7(c), the upper tie bar 65 is configured so as to connect the terminal connection 61a disposed in the middle portion on the right side with the terminal connection 63a disposed in the upper portion on the left side. Further, the lower tie bar 66 is configured so as to connect the terminal connection 61a disposed in the middle portion on the right side with the terminal connection 62a disposed in the lower portion on the left side. Further, the upper left tie bar 67 is configured so as to connect the terminal connection 63a disposed in the upper portion on the left side with the terminal connection 64a disposed in the middle portion on the left side. Further, the lower left tie bar 68 is configured so as to connect the terminal connection 62a disposed in the lower portion on the left side with the terminal connection 64a disposed in the middle portion on the left side.

[0031]

Referring to FIG. 7(c), the terminal 61 for imputing signal (Vc) (hereinafter, "Vc terminal ") includes the terminal connection 61a, as well as a capacitor connection 61b, an upper IC terminal connection 61c and a lower IC terminal connection 61d. The capacitor connection 61b is provided at the left end of the terminal connection 61a. Further, the upper IC terminal connection 61c extends upward from the capacitor connection 61b. Further, the lower IC terminal connection 61d extends downward from the capacitor connection 61b.

[0032]

Further, the terminal 62 for outputting signal (Vout 1) (herein after, "V1 terminal") includes the terminal connection 62a, as well as a capacitor connection 62b and an IC terminal connection 62c. The terminal connection 62a is formed between the lower tie bar 66 and the left lower tie bar 68. The capacitor connection 62b is provided at the right end of the terminal connection 62a. Further, the IC terminal connection 62c extends upward from the capacitor connection 62b.

[0033]

Further, the terminal 63 for outputting signal (Vout2) (hereinafter, the "V2 terminal"), which includes the terminal connection 63a, as well as a capacitor connection 63b and an IC terminal connection 63c, is formed symmetrically about the V1 terminal 62 as the left-right axis. The terminal connection 63a is formed between the upper tie bar 65 and the left upper tie bar 67. Thus, the capacitor connection 63b is provided at the right end of the terminal connection 63a. Further, the IC terminal connection 63c extends downward from the capacitor connection 63b.

[0034]

Further, the terminal 64 for grounding (GND) (hereinafter "GND terminal") includes the terminal connection 64a, as well as a middle capacitor connection 64b, an upper IC terminal connection 64c, an upper capacitor connection 64d, a lower IC terminal connection 64e and a lower capacitor connection 61f. The terminal connection 64a is formed between the left upper tie bar 67 and the left lower tie bar 68. The middle capacitor connection 64b is provided at the right end of the terminal connection 64a. Further, the upper IC terminal connection 64c extends upward from the capacitor connection 64b so as to be parallel to and between the upper IC terminal connection 61c of the Vc terminal 61 and the IC terminal connection 63c of the V2 terminal 63. Further, the upper capacitor connection 64d is provided at the upper end of the upper IC terminal connection 64c. Further, the lower IC terminal connection 64e extends downward from the middle capacitor connection 64b so as to be parallel to and between the upper IC terminal connection 61c of the Vc terminal 61 and the IC terminal connection 63c of the V2 terminal 63. Further, the lower capacitor connection 64f is provided at the lower end of the lower IC terminal connection 64e.

[0035]

Thus, the respective capacitor connections 61b, 62b, 63b, 64d, 64f (see FIG. 7(c)) are provided on the same plane F1 (see FIG. 7(b)).

Further, each IC terminal connection 61d, 62c, 64e (see FIG. 7 (c)) on the lower side is provided on the same plane F2, which is displaced slightly rearward from plane F1 (rightward as viewed in FIG. 7(b)).

Further, each IC terminal connection 61c, 63c, 64c (see FIG. 7(c)) on the upper side is provided on the same plane F3, which is displaced further rearward from plane F2 (rightward as viewed in FIG. 7(b)).

Further, the external ends of the terminal connections 61a, 62a, 63a, 64a (see FIG. 12) and each tie bar 65, 66, 67, 68 are provided on the same plane F4, which is displaced further rearward from plane F3 (rightward as viewed in FIG. 7(b)).

Further, as shown in FIG. 7(a), the middle portion of the top of the upper tie bar 65 is provided with a stepped portion 65a, which is disposed upward from each IC terminal connection 61c, 63c, 64c on the upper side. Further, the middle portion of the bottom of the lower tie bar 66 is provided with a stepped portion 66a, which is disposed downward from each IC terminal connection 61d, 62c, 64e on the lower side. Further, both of the stepped portions 65a, 66a are provided on the same plane F1 (see FIG. 7 (b)), on which the respective capacitor connections 61b, 62b, 63b, 64b, 64d, 64f are provided.

[0036]

As described above, since each portion is provided on predetermined planes F1, F2, F3, F4, the interconnection between these portions is provided with a folded portion, which extends from the front to the reverse. Thus, referring to FIG. 7(b), the terminal connection 62a and the capacitor connection 62b of the V1 terminal 62 are formed in a stepped shape via a folded portion 69a. Further, the terminal connection 63a and the capacitor connection 63b of the V2 terminal 63 are formed in a stepped shape via a folded portion 69b. Further, the terminal connection 64a and the capacitor connection 64b of the GND terminal 64 are formed in a stepped shape via a folded portion 69b. Further, the upper tie bar 65 is provided with a stepped portion 65a via both folded portions 69d on the left and the right sides. Further, the lower tie bar 66 is provided with a stepped portion 66a via both folded portions 69e on the left and the right sides. The other portions are also formed in a stepped manner via folded portions (numerical numbers are omitted) similar to those described above. It should be noted that the outer surface of the terminal unit 60 is plated with Ni (not shown).

[0037]

Then, the terminal assembly 70 will be described. As shown in FIGS. 8(a) and 8(b), the terminal assembly 70 is configured such that the terminal unit 60 is implemented with the respective sensor ICs 50(1), 50(2) and the capacitors 81, 82, 83, 84 (see FIG. 11). Thus, the

first sensor IC 50(1) and the second sensor IC 50(2) are oppositely disposed on the front of the terminal unit 60, such that the magnetic sensing portion 51 of the second sensor IC 50(2) is overlapped against the reverse side (the right side as viewed in FIG. 8(a)) of the magnetic sensing portion 51 of the first sensor IC 50(1).

Under this condition, the input connection terminal 55 of the first sensor IC 50(1) is electrically connected with the lower IC terminal connection 61d of the Vc terminal 61 of the terminal unit 60 by welding (the welded portion is designated as 71 in FIG. 8(b)).

Further, the ground connection terminal 56 of the first sensor IC 50(1) is electrically connected with the lower IC terminal connection 64e of the GND terminal 64 of the terminal unit 60 by welding (the welded portion is designated as 72 in FIG. 8(b)).

Further, the output connection terminal 57 of the first sensor IC 50(1) is electrically connected with the IC terminal connection 62c of the V1 terminal 62 of the terminal unit 60 by welding (the welded portion is designated as 73 in FIG. 8(b)).

Further, the input connection terminal 55 of the second sensor IC 50(2) is electrically connected with the upper IC terminal connection 61c of the Vc terminal 61 of the terminal unit 60 by welding (the welded portion is designated as 74 in FIG. 8(b)).

Further, the ground connection terminal 56 of the second sensor IC 50(2) is electrically connected with the upper IC terminal connection 64c of the GND terminal 64 of the terminal unit 60 by welding (the welded portion is designated as 75 in FIG. 8(b)).

Further, the output connection terminal 57 of the second sensor IC 50(2) is electrically connected with the IC terminal connection 63c of the V2 terminal 63 of the terminal unit 60 by welding (the welded portion is designated as 76 in FIG. 8(b)).

It should be noted that the respective welded portions 71 to 76 might be welded, for example, by projection welding.

[0038]

Further, as shown in FIG. 8(b), the first capacitor 81 and the second capacitor 82 are connected electrically and parallel in the left-right direction by soldering between the capacitor connection 61b of the Vc terminal 61 and the middle capacitor connection 64b of the GND terminal 64 on the reverse of the terminal unit 60.

Further, a third capacitor 83 is electrically connected by soldering between the capacitor connection 62b of the V1 terminal 62 and the lower capacitor connection 64f of the GND terminal 64.

Further, a fourth capacitor 84 is electrically connected by soldering between the capacitor connection 63b of the V2 terminal 63 and the upper capacitor connection 64d of the GND terminal 64.

It should be noted that each capacitor 81, 82, 83, 84 serves as a preventive measure for discharge of positive charges such that high voltages due to static electricity may not be applied to the respective sensor ICs 50(1), 50(2).

[0039]

Then, the holder 90 will be described. It should be noted that FIG. 9(a) is a front view showing the holder 90; FIG. 9(b) is a side sectional view; and FIG. 9(c) is a rear view showing the holder 90.

The holder 90, which is, for example, made of resin, is configured to mainly have a closed-end rectangular cylinder shaped hollow tube portion 91 that closes the front side and opens the rear side (see FIG. 9(b)). The rear side (the right side in FIG. 9(b)) of the hollow tube portion 91 is provided continuously with an enlarged tube portion 93 such that the opening is enlarged via an intermediate end plate portion 92.

[0040]

Guiding grooves 94 are provided in the middle portion of the opposed wall surfaces of both the left and the right sidewalls 91a, 91b (see FIG. 9(c)) of the hollow tube portion 91 in such a manner that the grooves 94 extend in the front-rear direction (the left-right direction in FIG. 9(b)).

In FIG. 9(b), the bottom ends of the guiding grooves 94 (the ends on the bottom end surface 91e side of the hollow tube portion 91) are formed as positioning grooves 94a, the widths (the widths extending in the up-down direction in FIG. 9(b)) of which are configured to receive the projecting pieces 54 (see FIG. 6(b)) projecting from both the left and the right sides of the magnetic sensing portions 51 (see FIG. 8(a)) of the sensor ICs 50(1), 50(2).

Further, the portions extending from the positioning grooves 94a of the guiding grooves 94 to the opening end surface of the hollow tube portion 91 are formed as tapered grooves 94b configured in a tapered shape so as to be gradually enlarged from the positioning grooves 94a to the opening end surface of the hollow tube portion 91.

Further, the spacing defined between both the left and the right sidewalls 91a, 91b of the hollow tube portion 91 (see FIG. 9(c)) is configured to be substantially equal to the width (the width extending in the up-down direction in FIG. 6) of the magnetic sensing portion 51 and the computing portion 52 of the respective sensor ICs 50(1), 50(2).

[0041]

Then, the sensor assembly 100 will be described. It should be noted that FIG. 10(a) is a front view; FIG. 10(b) is a side sectional view; and FIG. 10(c) is a rear view of the sensor assembly.

The sensor assembly 100 includes the terminal assembly 70 and the holder 90 (see FIG. 11). As shown in FIGS. 10(a), 10(b) and 10(c), each sensor IC 50(1), 50(2) of the sensor assembly 100 is housed in the hollow tube portion 91 of the holder 90.

At this point, each projecting piece 54 of the magnetic sensing portion 51 of the first sensor IC 50(1) is engaged into the positioning groove 94a (see FIG. 9(b)) from the tapered groove 94b of each guiding groove 94 on the left or the right of the holder 90 so as to be positioned. Accordingly, the magnetic sensing portion 51 of the first sensor IC 50(1) abuts on the bottom end surface 91e of the hollow tube portion 91 of the holder 90 in surface-to-surface contacting manner, while the computing portion 52 abuts on the lower wall surface 91d of the hollow tube portion 91 of the holder 90 in surface-to-surface contacting manner.

Subsequently, each projecting piece 54 of the magnetic sensing portion 51 of the second sensor IC 50(2) is positioned by being engaged into the positioning groove 94a (see FIG. 9(b)) from the tapered groove 94b of each guiding groove 94 on the left or the right of the holder 90. Accordingly, the computing portion 52 of the second sensor IC 50(2) abuts on the upper wall surface 91c of the hollow tube portion 91 of the holder 90 in surface-to-surface contacting manner.

As described above, the center of the magnetic sensing portion 51 of each sensor IC 50(1), 50(2) is aligned with the axis of the hollow tube portion 91 of the holder 90 (see FIG. 10(b)).

[0042]

When each sensor IC 50(1), 50(2) is housed into the hollow tube portion 91 of the holder 90 as described above, the connection portion between each connection terminal 55, 56, 57 of each sensor IC 50(1), 50(2) with each terminal 61, 62, 63, 64, and each capacitor 81, 82, 83, 84 etc. are housed into the enlarged tube portion 93 of the holder 90. Further, the each terminal connection 61a, 62a, 63a, 64a and each tie bar 65, 66, 67, 68 remain exposed from the enlarged tube portion 93 of the holder 90.

Under this condition, a potting material 102 is substantially entirely within the holder 90, for example, by a dispenser (not shown). Accordingly, each sensor IC 50(1), 50(2), each connection terminal 55, 56, 57 thereof, each capacitor 81, 82, 83, 84, and the housed portion of each terminal 61, 62, 63, 64 housed within the holder 90 are buried with a potting material 102 (see two-dot chain lines 102 in FIG. 10(b).

Further, a resin such as an epoxy resin, which is permanently soft but insufficient to inadvertently drip, is adopted as the potting material 102 such that each sensor IC 50(1), 50(2) and each capacitor 81, 82, 83, 84 are protected from thermal stress, vibration and the like.

Further, potting the potting material 102 into the hollow tube portion 91 of the holder 90 avoids the occurrence of distortions of the magnetic sensing portion 51 of each sensor IC 50(1), 50(2) such that declining of the detection accuracy due to the occurrence of distortions can be prevented. Although insert molding, for example, may lead to a problem of declining of the detection accuracy because the magnetic sensing portion 51 of each sensor IC 50(1), 50(2) is distorted by inserting pressure of the resin, it is possible to eliminate such a problem by potting the potting material 102.

[0043]

After potting the potting material 102, each tie bar 65, 66, 67, 68 of the terminal unit 60 is removed by cutting. Accordingly, each separated terminal 61, 62, 63, 64 is formed. FIG. 12 shows the sensor assembly in which the tie bars of the terminal unit have been cut and (a) is a front view, (b) is a side sectional view, and(c) is a broken-away bottom view.

[0044]

Then, the sensor terminal unit 110 will be described. FIG. 13 is a front view of the sensor terminal unit 110.

The sensor terminal unit 110 is formed by press molding an electrically conductive sheet stock such as a copper alloy plate. The sensor terminal unit 110 includes the Vc sensor terminal 111, the V1 sensor terminal 112, the V2 sensor terminal 113, and the GND sensor terminal 114. Then, the adjacent sensor terminals 111, 112, 113, 114 are connected with each other by each tie bar 115a, 115b, 115c, 116a, 116b, 116c.

[0045]

Referring to FIG. 13, the Vc sensor terminal 111 includes the terminal connection end 111a provided at one end thereof or the right end of the terminal connection side, and the external connection end 112b provided at the other end thereof. The terminal connection end 111a is formed to be connectable with the terminal connection 61a (see FIG. 12(a)) of the Vc terminal 61 of the sensor assembly 100.

Further, the V1 sensor terminal 112 is formed along the lower side of the Vc sensor terminal and includes a terminal connection end 112a formed at one end thereof and the external connection end 112b formed at the other end thereof. Further, the external connection end 112a is formed to be connectable with the terminal connection 62a (see FIG. 12(a)) of the V1 terminal 62 in the sensor assembly 100.

Further, the V2 sensor terminal 113 is formed on the upper side of the Vc sensor terminal 111 and includes a terminal connection end 113a provided at one end thereof and the external connection end 113b provided at the other end thereof. The terminal connection end 113a is formed so as to be connectable with the terminal connection 63a (see FIG. 12(a)) of the V2 terminal 63 in the sensor assembly 100.

Further, the GND sensor terminal 114 is formed along the upper side of the V2 sensor terminal 113 and includes a terminal connection end 114a provided at one end thereof and the external connection end 114b provided at the other end thereof. The terminal connection end 114a is formed so as to be connectable with the terminal connection 64a (see FIG. 12(a)) of the GND terminal 64 in the sensor assembly 100.

[0046]

Further, the external connection ends 111b, 112b, 113b, 114b of the sensor terminals 111, 112, 113, 114 extend downward in such a manner that are arranged parallel in the left and right direction.

The tie bars 115a, 115b, 115c on the terminal connection side and the tie bars 116a, 116b, 116c on the external connection end side connect between adjacent sensor terminals of the sensor terminals 111, 112, 113, 114. The tie bars 115a, 115b, and 115c on the terminal connecting end side are arranged in a row in the upward and downward direction. The tie bars 116a, 116b and 116c on the external connection end side are arranged in a row in the left and right direction. It should be noted that the outer surface of the sensor terminal unit 110 is plated with Ni (not shown), while each terminal connection end 111a, 112a, 113a, 114a, is plated with Au.

[0047]

Then, the sensor terminal assembly 120 will be described. FIG. 14 is a front view of the sensor terminal assembly.

The sensor terminal assembly 120 is configured such that the sensor terminal unit 110 is implemented with the sensor assembly 100 (see FIG. 12).

Thus, the terminal connection 61a of the Vc terminal 61 of the sensor assembly 100 is electrically connected on the terminal connection end 111a of the Vc sensor terminal 111 of the sensor terminal unit 110 by welding (the welded portion is designated as 121).

Further, the terminal connection 62a of the V1 terminal 62 of the sensor assembly 100 is electrically connected on the terminal connection end 112a of the V1 sensor terminal 112 of the sensor terminal unit 110 by welding (the welded portion is designated as 122).

Further, the terminal connection 63a of the V2 terminal 63 of the sensor assembly 100 is electrically connected on the terminal connection end 113a of the V2 sensor terminal 113 of the sensor terminal unit 110 by welding (the welded portion is designated as 123).

Further, the terminal connection 64a of the GND terminal 64 of the sensor assembly 100 is electrically connected on the terminal connection end 114a of the GND sensor terminal 114 of the sensor terminal unit 110 by welding (the welded portion is designated as 124).

It should be noted that the respective welded portions 121, 122, 123, 124 might be welded, for example, by projection welding.

[0048]

After the welding, each tie bar 115a, 115b, 115c, 116a, 116b, 116c of the sensor terminal unit 110 is removed by cutting. Accordingly, separated sensor terminals 111, 112, 113, 114 are formed. It should be noted that FIG. 15 shows a front view of the sensor terminal assembly 120 in which the tie bars have been cut.

[0049]

Then, the cover 30 will be described. As shown in FIG. 2, the cover 30 is formed in such a way that the sensor terminal assembly 120 (see FIG. 15), the relay connectors 36 and the plate terminals 37, 38 (see FIG. 16 and FIG. 17) are insert molded or inserted to be resin molded.

Further, as shown in FIG. 2, the external connection ends 111b, 112b, 113b, 114b of the sensor terminals 111, 112, 113, 114, as well as the external connection ends 37b, 38b of the plate terminals 37, 38, project downwardly within the connector portion 40 of the cover 30 (see FIG.2 and FIG. 4).

Further, the external connection ends 37b, 38b, 111b, 112b, 113b, 114b are arranged in a row in the left-right direction in FIG. 4. It should be noted that the external connection ends 38b, 37b, 114b, 113b, 111b, 112b are arranged in a row in the left and right direction in FIG. 4 in this embodiment.

Further, as previously described, each external connection end 111b, 112b, 113b, 114b, 37b, 38b is connectable with each terminal pin (not shown) within the external connector (not shown) connected with the connector portion 40.

The cover 30, the relay connectors 36, and the plate terminals 37, 38, sensor terminal assembly 120 such that the rotational angle sensor (numerical number, Se is allocated) is configured.

[0050]

The cover 30 for the rotational angle sensor Se configured as above is connected with the throttle body 1 as shown in FIG.1 so as to complete the throttle control device. Accordingly, the hollow tube portion 91 of the holder 90 of the rotational angle sensor Se is disposed substantially concentric with the axis of the yoke 43 or the rotational axis L of the throttle shaft 6 so as to be between the magnets 44, 45 and in predetermined spaced relationship with each magnet.

Further, since the magnetic sensing portions 51 of the sensor ICs 50(1), 50(2) of the rotational angle sensor Se are disposed between the magnets 44, 45 such that the rotational axis L of the throttle shaft 6 is substantially concentric with the sensing portions 51 and also orthogonal with the square surfaces of the magnetic sensing portions 51, the magnetic field direction generated between the pair of magnets 44, 45 is accurately detected.

[0051]

Thus, the sensor ICs 50(1), 50(2) (see FIG. 3) allow the computing portions 52 to calculate outputs from the magnetoresistive elements within the magnetic sensing portions 51 and to output signals representing the magnetic field direction to the control means such as ECU so as to be configured to detect the magnetic field direction without depending on the magnetic field intensity.

Further, since two sensor ICs are used, it is possible to perform detection with a high accuracy. Also, even if either of them fails, the remaining one can detect the magnetic field direction.

[0052]

In the aforementioned throttle control device, when the engine is started, the drive of the motor 20 is controlled by a control means such as ECU. Accordingly, as previously described, an intake airflow flowing through the intake air passageway 4 (see, FIG. 1) of the throttle body 1 is controlled by opening and closing the throttle valve 12 via the speed-reduction gear mechanism 29. Then, as the throttle shaft 6 rotates, the throttle gear 16, the yoke 43, and both of the magnets 44, 45 rotate such that the magnetic field direction intersecting each sensor IC 50(1), 50(2) varies according to the rotational angle. Accordingly, an output signal from each sensor IC 50(1), 50(2) varies. The control means such as ECU (not shown), to which each sensor IC 50(1), 50(2) outputs the output signal, calculates the rotational angle of the throttle shaft 6, or the opening degree of the throttle valve 12, based on the output signal from each sensor IC 50(1), 50(2).

[0053]

Further, the control means such as ECU (not shown) controls the so-called control parameters for a fuel injection control, a control for correcting the opening degree of the throttle valve 12, a speed-change control of an automatic transmission, etc., based on the throttle opening degree detected as the magnetic field direction representing the magnetic physical quantity of the pair of magnets 44, 45 and outputted from each sensor IC 50(1), 50(2) of the rotational angle sensor Se, a driving speed detected by a vehicle speed sensor (not shown), an engine rotational speed detected by a crank angle sensor, a detection signal from an accelerator pedal sensor, an O_2 sensor, and an air flow meter, etc.

[0054]

According to the rotational angle sensor Se (see FIGS. 2 and 3) provided in the aforementioned throttle control device, connection terminals 55, 56, 57 of sensor ICs 50(1), 50(2) for detecting a rotational angle of the throttle gear 16 are directly connected to respective terminals 61, 62, 63, 64. Therefore, it is possible to lower the cost by using inexpensive terminals 61, 62, 63, 64, comparing to expensive printed circuit boards that have conventionally been required

[0055]

Further, constructing the sensor assembly 100 (see FIG. 12) by assembling the sensor ICs 50(1), 50(2), the terminals 61, 62, 63, 64 and the holder 90 is advantageous in handling the sensor ICs 50(1), 50(2) and the terminals 61, 62, 63, 64. Further, it is possible to reduce the size of the sensor assembly, because the structure is more simplified than in using a printed circuit board. Accordingly, it is possible to reduce the equipment expenses so as to lower the cost.

[0056]

Further, a potting material 102 is potted into the holder 90 so as to cover each sensor IC 50(1), 50(2), and the connection portions between each connection terminal 55, 56, 57 of each sensor IC 50(1), 50(2) and each terminal 61, 62, 63, 64 (see, FIG. 10 (b)).

Thus, it is possible to prevent the intrusion of moisture to the electrically conductive portions so as to prevent or reduce the occurrence of shunt or short and migration. Additionally, when the potting material 102 has flexibility, it is possible to protect each sensor IC 50(1), 50(2) from thermal stress, vibrations and the like. Additionally, since no excess pressure is applied to each sensor IC 50(1), 50(2) when it is potted, it is possible to avoid characteristic changes of each sensor IC 50(1), 50(2) caused by the pressure. For these reasons, it is possible to increase the reliability of the rotational angle sensor Se.

Further, when a printed circuit board is used, covering the printed circuit board requires plenty of potting material, but conversely, covering or molding the connection portions between each connection terminal 55, 56, 57 of each sensor IC 50(1), 50(2) and each terminal 61, 62, 63, 64 with a potting material 102 reduces the potting material 102 used such that it is possible to lower the material cost for the potting material.

Further, using an epoxy resin, which is less expensive than a silicon-type UV curable resin, as the potting material 102 can avoid increasing the cost. It should be noted that the silicon-type UV curable resin could be adopted as the potting material 102.

[0057]

Further, each capacitor 81, 82, 83, 84 as a preventive measure for discharge of positive charges is connected between one and another of the terminal 61, 62, 63, 64 and covered with the potting material 102 (see FIG. 10(b)). Thus, the potting material 102 having flexibility may protect the capacitors 81, 82, 83, 84 from thermal stress, vibrations and the like. Further, since no excess pressure is applied to the capacitors 81, 82, 83, 84 when they are potted, it is possible to avoid disconnection, destruction and the like of the capacitors 81, 82, 83, 84 caused by the pressure. Accordingly, it is possible to increase the reliability of the rotational angle sensor Se.

[0058]

Further, the resin molded cover (stationary body) 30 (see FIGS. 2 and 3) is provided. Accordingly, the cover 30 including the sensor assembly 100 may be easily formed

[0059]

Further, each connection terminal 55, 56, 57 of each sensor IC 50(1), 50(2) and each main terminal 61, 62, 63, 64 are connected by welding (see welded portions 71 to 76 in FIG. 8(b)). Thus, since the strength of the connection between each connection terminal 55, 56, 57 of each sensor IC 50(1), 50(2) and each main terminal 61, 62, 63, 64 is enhanced, it is possible to prevent or reduce disconnection caused by repeated temperature cycles.

[0060]

Further, the aforementioned method for manufacturing the rotational angle sensor Se includes the steps of:

press molding an electrically conductive sheet stock so as to form the terminal unit 60 in which the terminals 61, 62, 63, 64 are connected via the tie bars 65, 66, 67, 68;

connecting the connection terminals 55, 56, 57 of the sensor ICs 50(1), 50(2) with the terminal unit 60; and

removing tie bars 65, 66, 67, 68 from the terminal unit 60 to which connection terminals 56, 56, 57 are connected.

Therefore, according to this manufacturing method, press molding a sheet stock so as to form the terminal unit 60 enables the terminals 61, 62, 63, 64 to be accurately formed.

Further, connecting the connection terminals 55, 56, 57 of the sensor ICs 50(1), 50(2) with the terminal unit 60 enables the connection terminals 55, 56, 57 of the sensor ICs 50(1), 50(2) to be accurately connected with the terminals 61, 62, 63, 64.

Further, removing the tie bars 65, 66, 67, 68 from the terminal unit 60 to which connection terminals of the ICs 50(1), 50(2) are connected enables to form individually independent terminals 61, 62, 63, 64.

Therefore, the rotational angle sensor Se can be rationally manufactured.

[0061]

Further, the throttle control device (see FIG. 1) is constructed to include the rotational angle sensor Se so as to detect opening degrees of the throttle valve 12. Therefore, it is possible to provide the throttle control device providing equivalent function and effect with the rotational angle sensor Se.

[0062]

Further, since the opened ends of the guiding grooves 94 of the holder member 90 is provided with the tapered grooves 94b (see FIG. 9(b)), the area where the projecting pieces 54 are engageable with the tapered grooves 94b can be greater. Thus, it is possible to facilitate engaging the projecting pieces 54 of the magnetic sensing portions 51 of the sensor ICs 50(1), 50(2) with the positioning grooves 94a. Thereafter, the projecting pieces 54 are guided by the tapered grooves 94b toward the positioning grooves 94a, and then the projecting pieces 54 are finally positioned at predetermined positions in the positioning grooves 94a.

Accordingly, it is possible to easily and accurately position the projecting pieces 54 of the magnetic sensing portions 51 of the sensor ICs 50(1), 50(2) at the projecting pieces 54 of the guiding grooves 94.

Eventually, the sensor ICs 50(1), 50(2) can be easily and accurately positioned at the predetermined accommodation positions within the holder member 90 (see FIG. 10(b)). Accordingly, it is possible to prevent or reduce displacement of each sensor IC 50(1), 50(2).

[0063]

Since the sensor terminals 111, 112, 113, 114 and the plate terminals 37, 38 are integrated into the cover 30 by integrally resin molding, it is possible to accurately dispose the

sensor terminals 111, 112, 113, 114 and the plate terminals 37, 38 in a predetermined position in the cover 30.

[0064]

Further, the magnetic field direction generated between the pair of magnets 44, 45 disposed in the throttle shaft 6 is detected by the sensor ICs 50(1), 50(2) such that the opening degrees of the throttle valve 12 are detected based on the outputs from the sensor ICs 50(1), 50(2) (see FIGS. 3 and 4). Therefore, the sensor ICs 50(1), 50(2) detecting the magnetic field direction are hardly affected, for example, by displacement of the magnet 44, 45 due to displacement of the throttle shaft 6, magnetic field intensity change due to the temperature characteristics of the magnets 44, 45 and the like. It should be noted that the displacement of the throttle shaft 6 is referred to as a relative displacement against the sensor ICs 50(1), 50(2), which is generated by assembly errors of the throttle shaft 6, thermal expansion errors between the throttle body 1 and the cover 30, rattling due to wearing of the throttle shaft 6 or the bearings 8, 10, thermal expansion of the resin (the throttle gear 16) molded by insert molding both of the magnets 44, 45 and the like.

Thus, it is possible to accurately detect the magnetic field direction by the sensor ICs 50(1), 50(2), and accordingly it is possible to increase the detection accuracy of the opening degrees of the throttle valve 12. This is particularly advantageous if the throttle body 1 is made of a resin that is insufficient in manufacturing accuracy. Further, this is advantageous if the throttle body 1 and the cover 30 are made in different materials, for example, in the case that the throttle body 1 is made of metal, while the cover 30 is made of resin.

[0065]

Further, the pair of magnets 44, 45 disposed in the throttle gear 16 and on the inner surface of the yoke 43 made of a ring-shaped magnetic material generally centered about the rotational axis L, and also parallel magnetized such that the magnetic fields generated between both are formed in a parallel relationship (see FIG. 4). Therefore, since a magnetic circuit including the pair of magnets 44, 45 and the yoke 43 so as to parallel magnetize the pair of magnets 44, 45, the magnetic field generated between the magnets 44, 45 are substantially parallel. Thus, it is possible to further increase the detection accuracy of the magnetic field direction by the sensor ICs 50(1), 50(2).

[Second Embodiment]

[0066]

A second embodiment of the present invention will be described. Since this embodiment is a modification of the terminal assembly 70 of the first embodiment, the same

description will not be duplicated further, but a modified part will be described. As shown in FIG. 18, the terminal unit 60 of the terminal assembly 70 of this embodiment is provided with the capacitors 81, 82, 83, 84 to be mounted on the same side as the connection side, i.e., the front side, of the sensor ICs 50(1), 50(2). Thus, the terminals 61, 62, 63, 64 of the terminal unit 60 are folded such that the capacitor connections 61b, 62b, 63b, 64b, 64d, 64f are disposed on plane F5 on the reverse side of the capacitors 81, 82, 83, 84 of the first embodiment.

Operations and effects similar to those of the first embodiment are obtained by the terminal assembly 70 in the second embodiment configured as above. Additionally, the sensor ICs 50(1), 50(2) and the capacitors 81, 82, 83, 84 can be easily positioned at the terminals 61, 62, 63, 64.

[0067]

The present invention may not be limited to the aforementioned embodiments, but may be modified without departing from the scope of the present invention. For example, in the magnetic detector, as long as the strength or direction of the magnetic field between a pair of magnets 44, 45 can be detected, it is possible to use a magnetic detection element such as a magnetoresistive element, a hall element and the like, a magnetic detector in which the magnetic sensing portion having a magnetic detection element is connected with the computing portion, and the like, instead of using each sensor IC. Further, the type of the magnets 44, 45 may not be limited to ferrite magnets. Further, the rotational angle sensor Se may not be limited to be used in the throttle control device, but may be diverted into a rotational angle sensor Se for another rotor. Further, it is possible to form terminals 61, 62, 63 and 64 and the sensor terminals 111, 112, 113 and 114 integrally and continuously, respectively.

[Brief Description of the Drawings]

[0068]

[FIG. 1] A cross-sectional plan view of a throttle control device, showing a first embodiment of the present invention;

[FIG. 2] A rear view showing a cover;

[FIG. 3] A cross-sectional view taken along line III-III in FIG. 2;

[FIG. 4] A bottom view showing a cover;

[FIG. 5] A front view showing the cover in partially broken away manner;

[FIG. 6] Views showing a sensor IC; (a) is a side view, (b) is a front surface view, (c) is a perspective view of a first sensor IC, (d) is a perspective view of a second sensor IC;

[FIG. 7] Views showing a terminal unit; (a) is a perspective view, (b) is a side view, and (c) is a rear view thereof;

[FIG. 8] View showing a terminal assembly; (a) is a side view, (b) is a rear view;

[FIG. 9] Views showing a holder member; (a) is a front view, (b) is a side sectional view, (c) is a rear view;

[FIG. 10] Views showing a sensor assembly; (a) is a front view, (b) is a side sectional view, (c) is a rear view

[FIG. 11] An exploded perspective view showing components of the sensor assembly;

[FIG. 12] Views showing the sensor assembly in which tie bars have been cut; (a) is a front view, (b) is a side sectional view, (c) is a rear view;

[FIG. 13] A front view showing a sensor terminal;

[FIG. 14] A front view showing a terminal assembly;

[FIG. 15] A front view showing the sensor assembly in which tie bars have been cut;

[FIG. 16] Views showing a first plate terminal; (a) is a front view, (b) is a side view;

[FIG. 17] Views showing a second plate terminal; (a) is a front view, (b) is a side view;

[FIG. 18] Vies showing a sensor assembly of a second embodiment; (a) is a front view, (b) is a side sectional view, (c) is a rear view.

[Description of Numerical Numbers]

[0069]

1 throttle body

4 intake air passageway

12 throttle valve

16 throttle gear (rotor)

20 motor

30 cover (stationary body)

50(1), 50(2) sensor IC (magnetic detection device)

55 input connection terminal

56 ground connection terminal

57 output connection terminal

60 terminal unit

61 signal input (Vc) terminal

62	signal output (V1) terminal
63	signal output (V2) terminal
64	ground (GND) terminal
65, 66, 67, 68	tie bar
81, 82, 83, 84	capacitor
90	holder
100	sensor assembly
102	potting material
Se	rotational angle sensor

[Name of Document] CLAIMS

[Claim 1]

A rotational angle sensor characterized by being provided with:

a magnetic detector for detecting a rotational angle of a rotor based on a magnetic field generated between a pair of magnets respectively disposed across the rotational axis of the rotor; and

terminals with which connection terminals of the magnetic detector are directly connected, respectively.

[Claim 2]

The rotational angle sensor as in claim 1, characterized by being provided with:

a holder member for housing the magnetic detector,

wherein the magnetic detector, the terminals and the holder member are formed into an assembly to be constructed as a sensor assembly.

[Claim 3]

The rotational angle sensor as in claim 2, characterized in that:

a potting material having flexibility is potted into the holder member so as to cover the magnetic detector and the connection portions between the connection terminals of the magnetic detector and the respective terminals.

[Claim 4]

The rotational angle sensor as in claim 3, characterized in that;

the rotational angle sensor is provided with capacitors as a preventive measure for discharge of positive charges, and

the capacitors are directly connected between the respective terminals and covered with the potting material.

[Claim 5]

The rotational angle sensor as in claim 4, characterized in that:

the capacitors are disposed in a plane on the same side as the connection side of the respective terminals connected with the magnetic detector.

[Claim 6]

The rotational angle sensor as in any one of claims 2 - 5, characterized in that:

a stationary body is provided which is resin molded with the sensor assembly is inserted.

[Claim 7]

The rotational angle sensor as in any one of claims 1 - 6, characterized in that:

the connection terminals of the magnetic detector and the respective terminals are connected by welding.

[Claim 8]

A method for manufacturing a rotational angle sensor including a magnetic detector for detecting a rotational angle of a rotor based on a magnetic field generated between a pair of magnets respectively disposed across the rotational axis of the rotor, and terminals, which connection terminals of the magnetic detector are directly connected, characterized in that the method comprises the steps of:

press molding an electrically conductive sheet stock so as to form a terminal unit in which the respective terminals are connected via tie bars;

connecting connection terminals of the magnetic detector with the terminal unit; and

removing the tie bars from the terminal unit to which the connection terminals of the magnetic detector are connected.

[Claim 9]

A throttle control device for driving a throttle valve, which rotatably opens and closes an intake air passageway provided in a throttle body by a motor, so as to control intake air flow flowing through the intake air passageway by opening and closing the intake air passageway, characterized in that:

the throttle control device is constructed to detect opening degrees of the throttle valve by using any one of the rotational angle sensors as in claims 1 to 7.

[Name of Document] ABSTRACT

[Abstract]

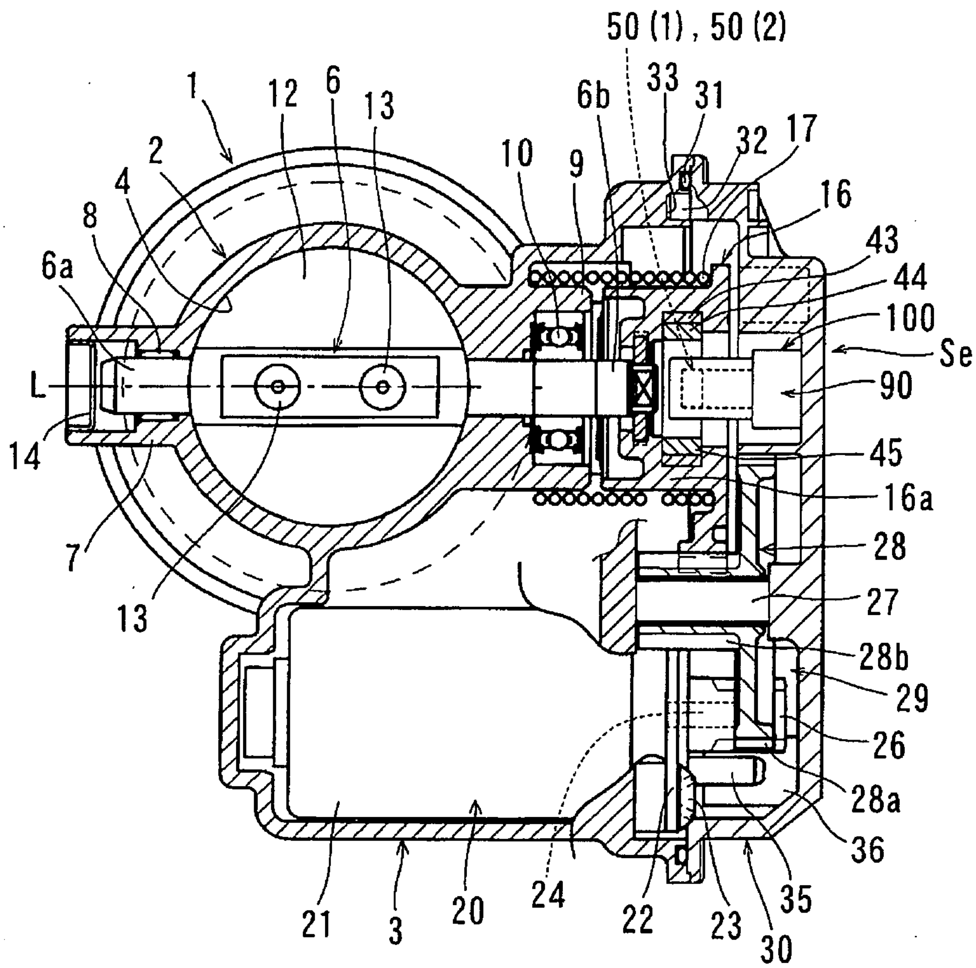
[Problem] Providing a rotational angle sensor, a method for manufacturing the same, and a throttle control device with the rotational angle sensor, which can reduce the cost.

[Means for Solving] The rotational angle sensor includes sensor ICs 50(1), 50(2) for detecting a rotational angle of a throttle gear 16 based on a magnetic field generated between a pair of magnets respectively disposed across the rotational axis L of the throttle gear 16, and terminals directly connected with connection terminals of sensor ICs 50(1), 50(2). A sensor assembly 100 is constructed by making the sensor ICs 50(1), 50(2), the terminals and the holder 90 into an assembly. A potting material is potted into the holder 90.

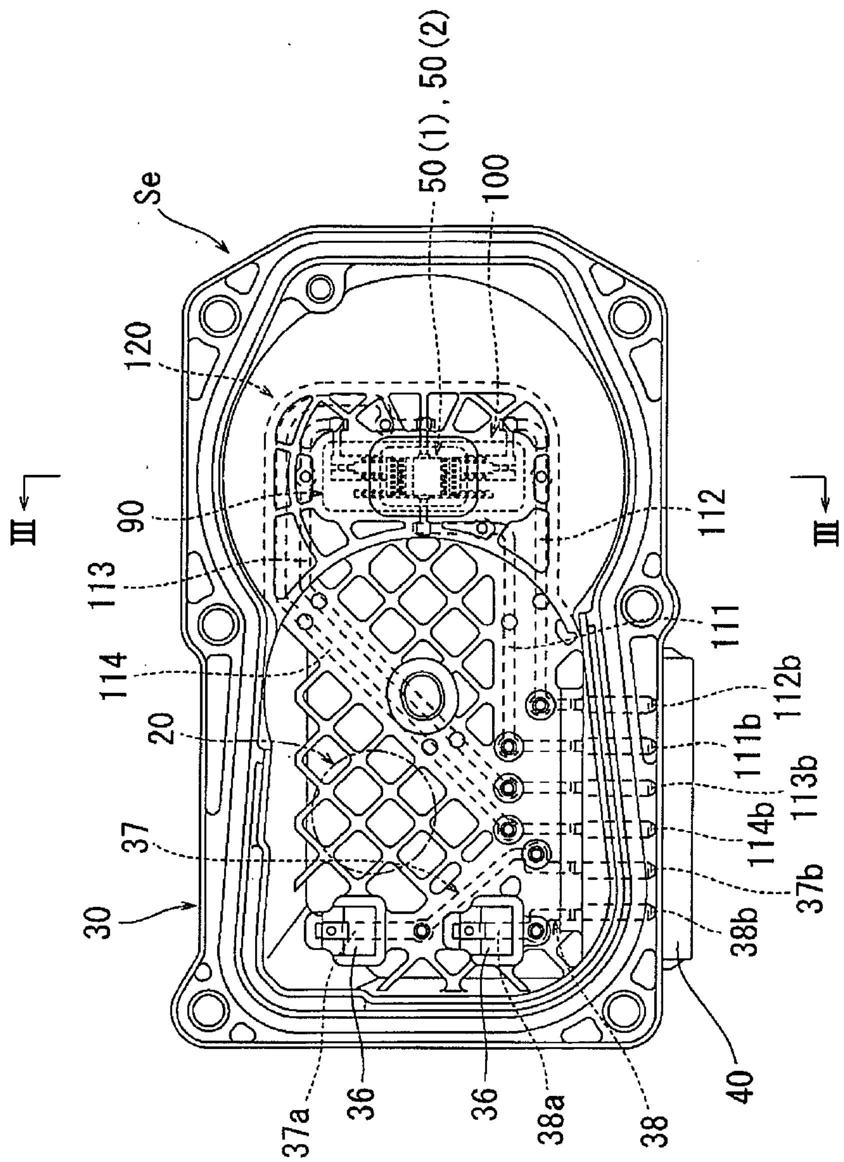
[Selected Figure] FIG. 1

【Name of Document】 Drawings

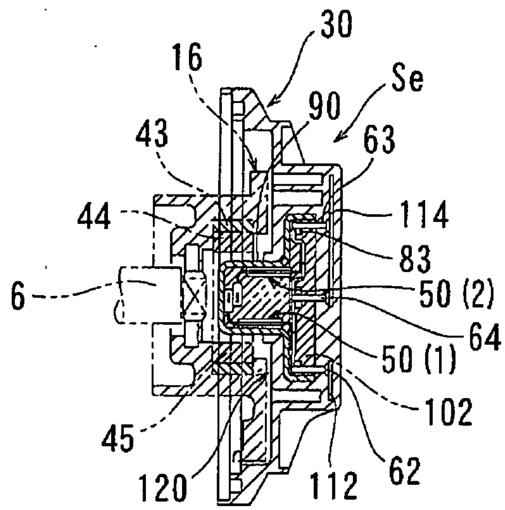
【FIG. 1】



【FIG. 2】

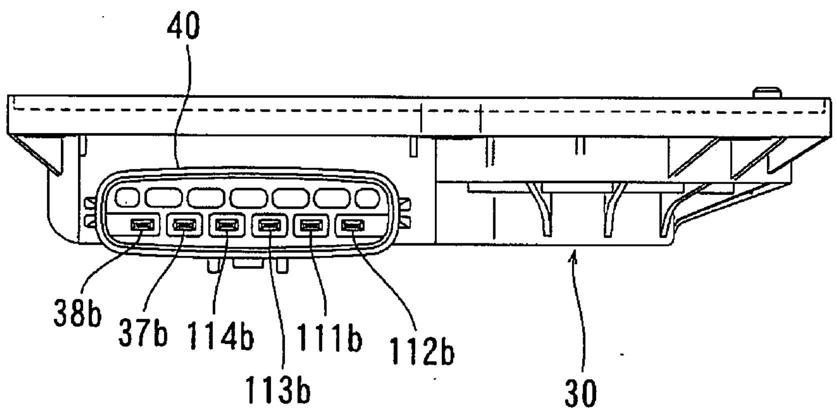

Se
50 (1) , 50 (2)
100
120
90
112
III
III
113
111
114
112b
111b
113b
114b
20
37
37b
38b
30
40
37a
36
36
38a
38

【FIG. 3】



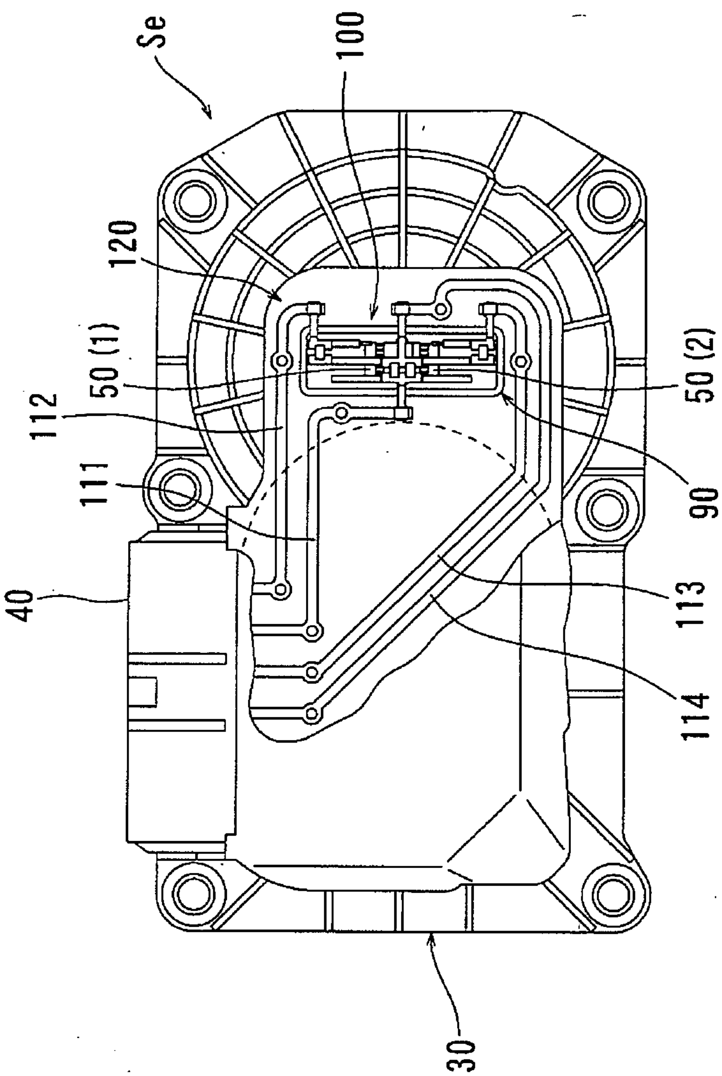
30
16
Se
90
43
63
114
44
83
6
50 (2)
64
50 (1)
102
45
62
120
112

【FIG. 4】



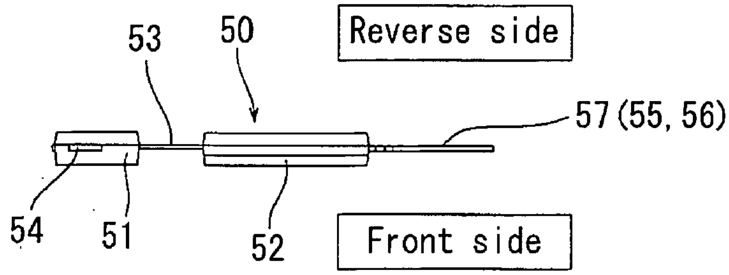
40
38b
37b
114b
111b
112b
113b
30

【FIG. 5】



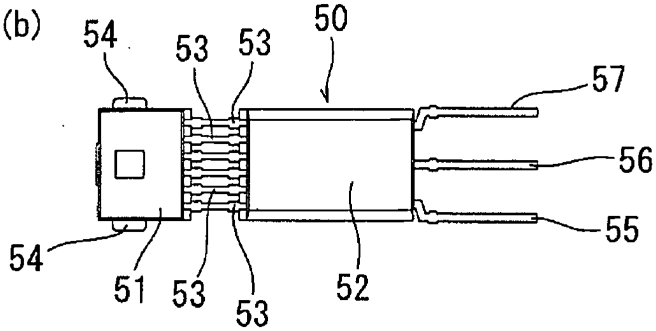
【FIG. 6】

(a)



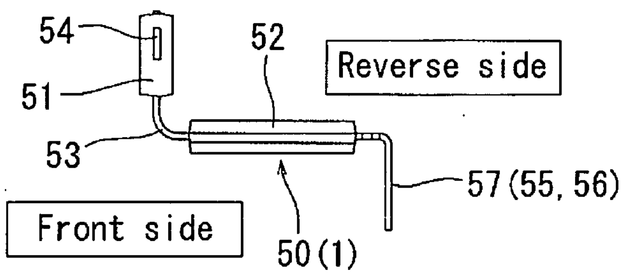
53
50
Reverse side
57 (55, 56)
54
51
52
Front side

(b)



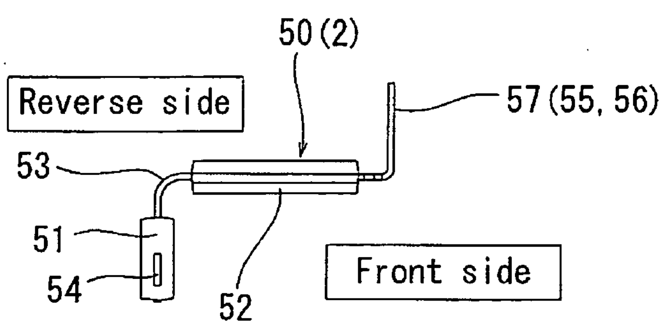
54
53
53
50
57
56
55
54
51
53
53
52

(c)



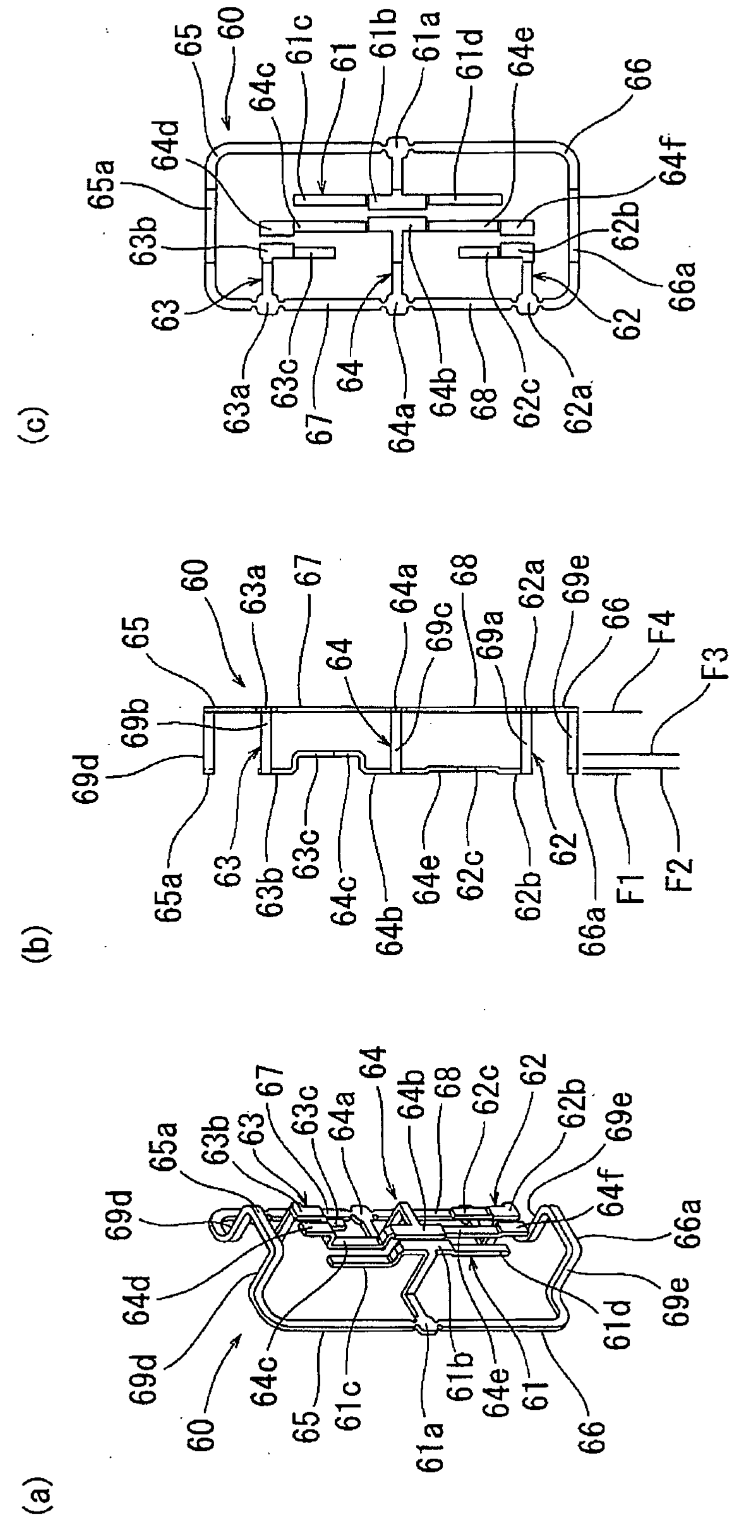
54
52
Reverse side
51
53
57 (55, 56)
Front side
50 (1)

(d)

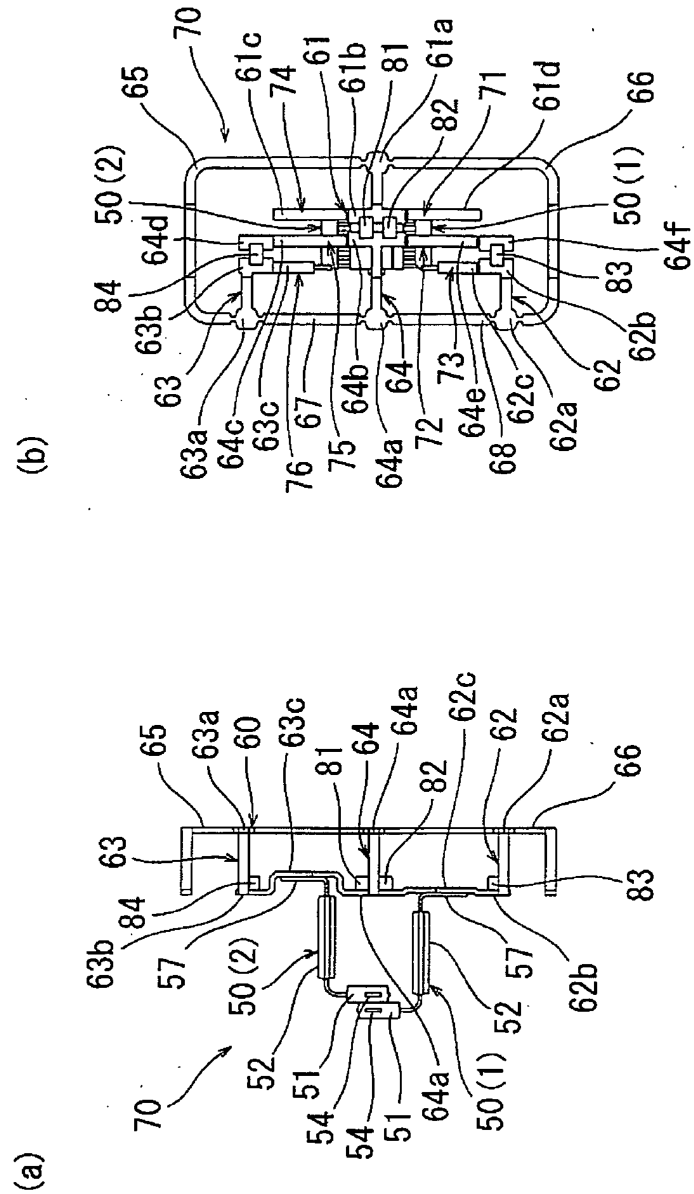


50 (2)
Reverse side
57 (55, 56)
53
51
54
52
Front side

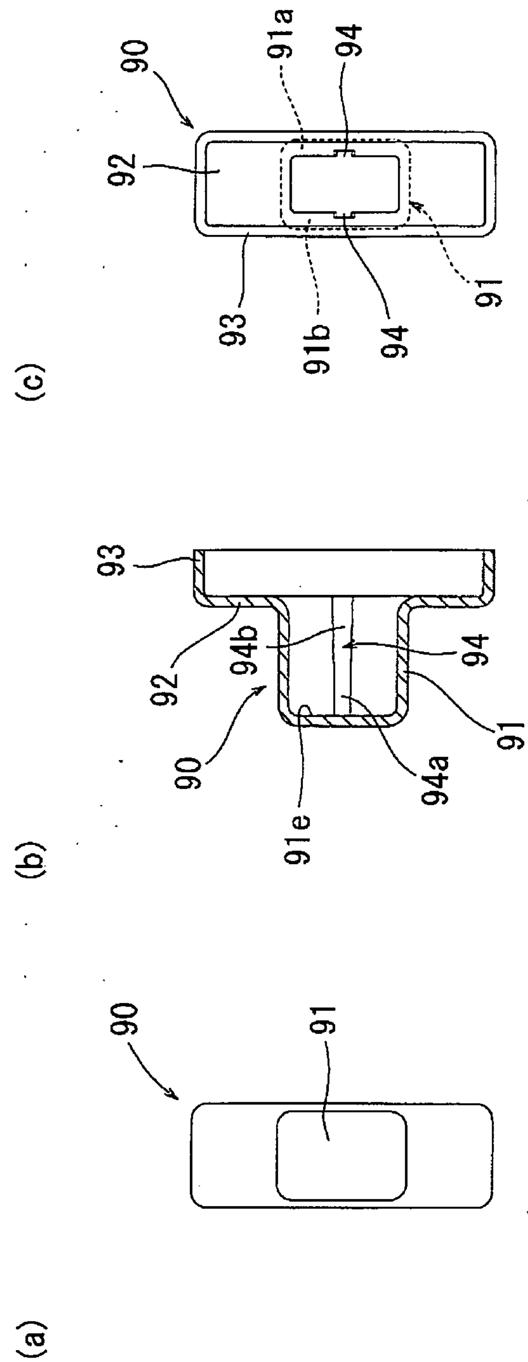
【FIG. 7】


(c)
60
65
65a
64d
64c
61c
61
61b
61a
61d
64e
66
64f
62b
66a
62
63b
63
63a
63c
67
64
64a
64b
68
62c
62a
(b)
60
65
69d
69b
63a
67
64
64a
69c
69a
68
62a
69e
66
F4
F3
65a
63
63b
63c
64c
64b
64e
62c
62b
62
66a
F1
F2
(a)
69d
65a
63b
63
67
63c
64a
64
64b
68
62c
62
62b
69e
64f
66a
64d
60
65
64c
61c
61a
61b
64e
61
61d
66

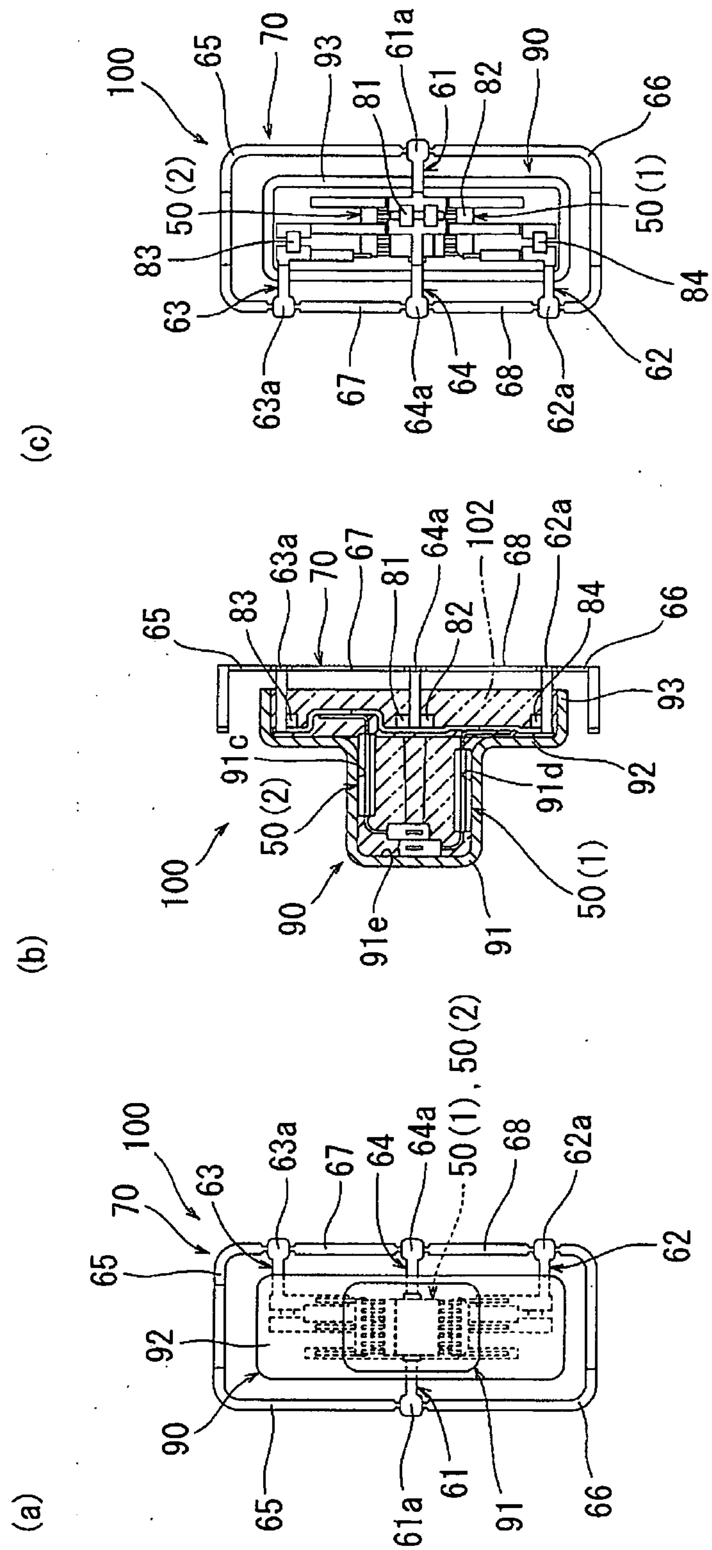
【FIG. 8】


(b)
70
65
61c
74
61
61b
81
61a
82
71
61d
66
50 (2)
64d
84
63b
63
63a
64c
63c
76
67
75
64b
64
64a
72
73
64e
68
62c
62a
62
62b
83
64f
50 (1)
(a)
65
63a
60
63c
81
64
64a
82
62c
62
62a
66
63
84
63b
57
50 (2)
52
70
51
54
54
51
64a
50 (1)
52
57
62b
83

【FIG. 9】

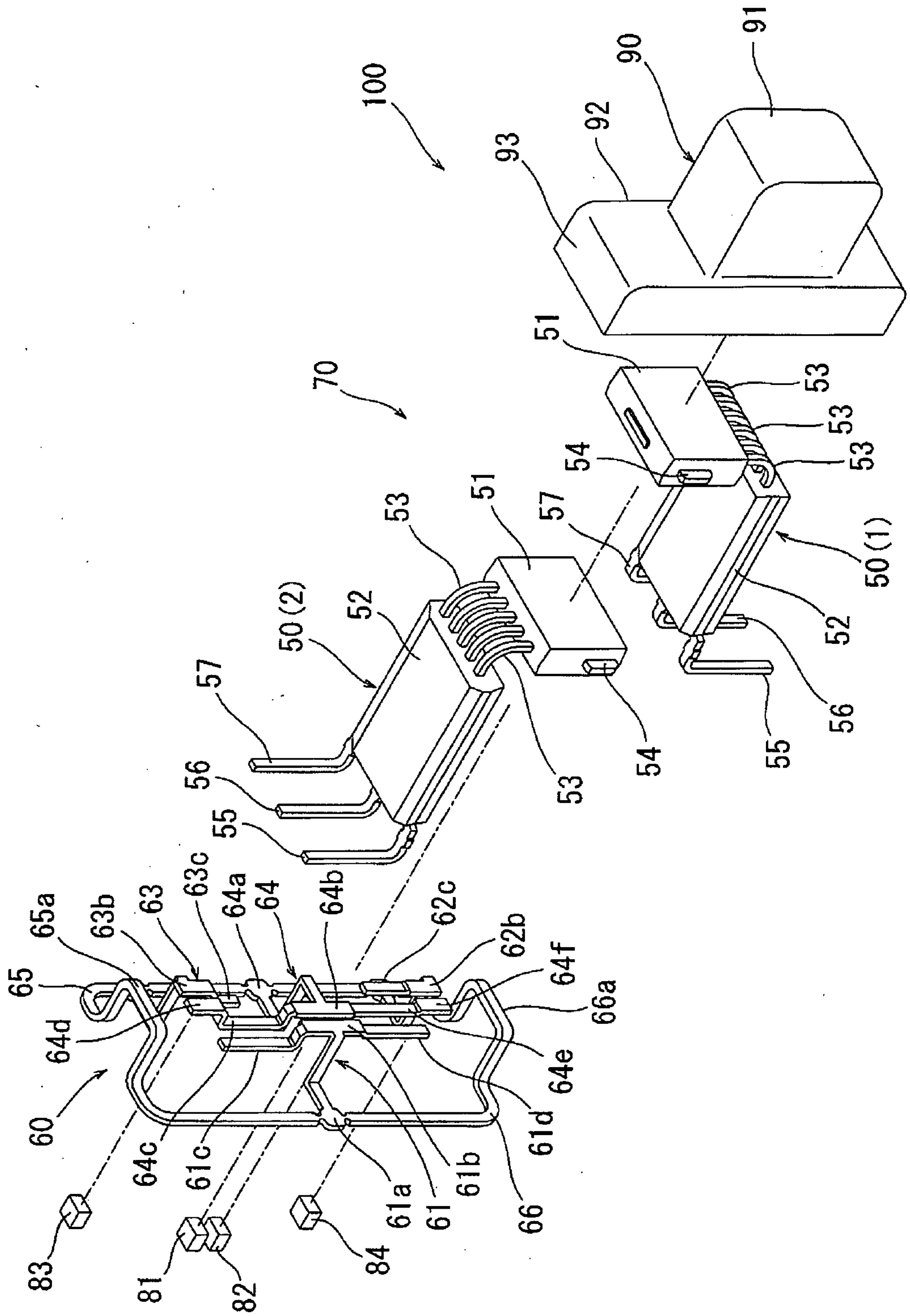


【FIG. 10】

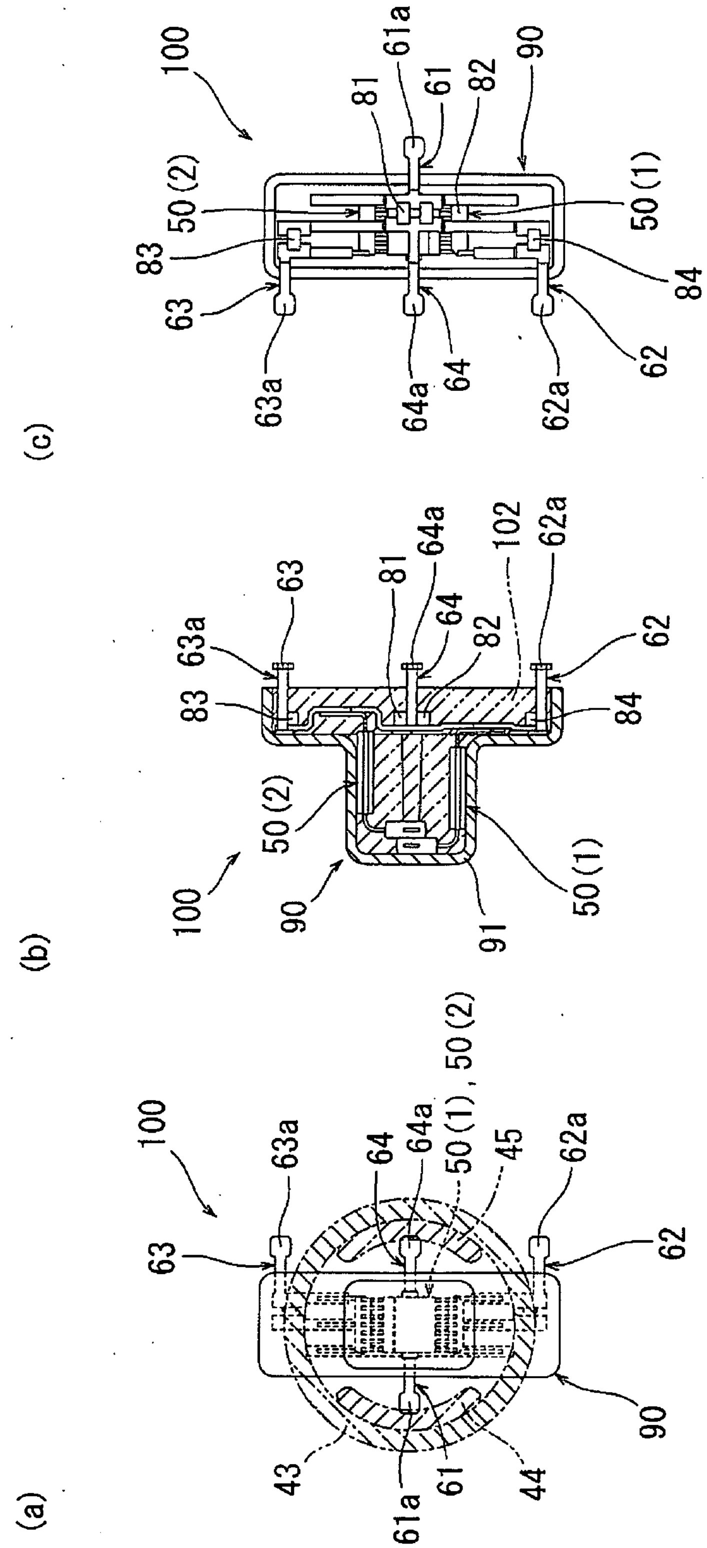


(a)
(b)
(c)
100
70
65
66
63
63a
67
64
64a
50(1), 50(2)
68
62a
62
92
90
61a
61
91
93
81
82
83
84
50(2)
50(1)
91c
91d
91e
102

【FIG. 11】

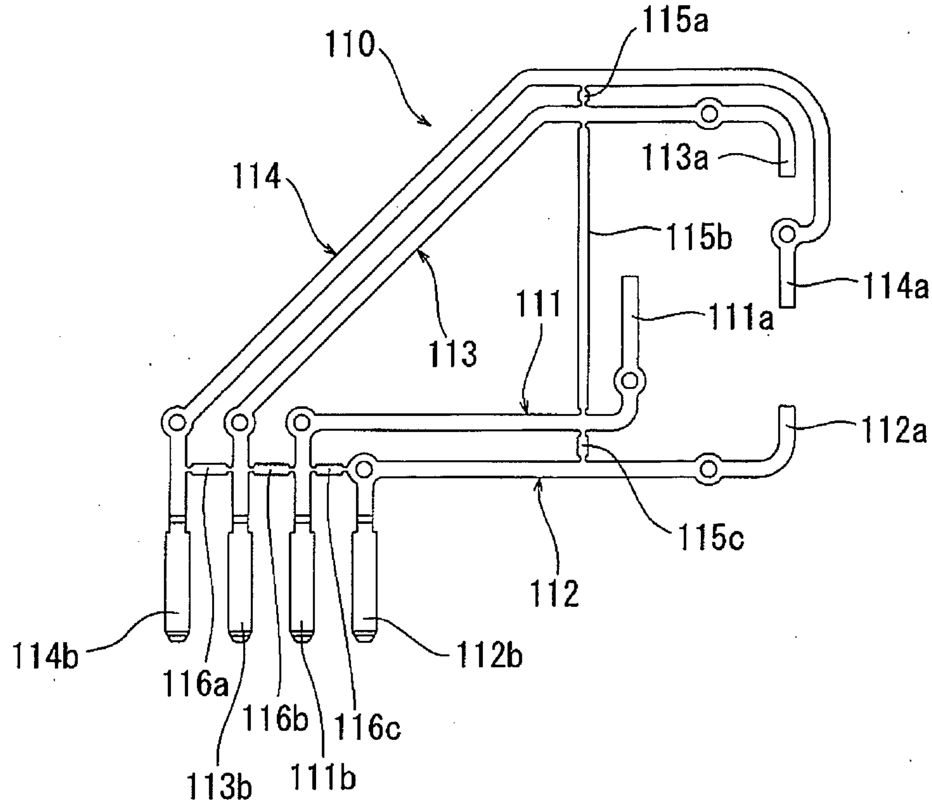

100
90
91
92
93
70
51
53
54
57
50(1)
52
56
55
50(2)
60
61
61a
61b
61c
61d
62b
62c
63
63b
63c
64
64a
64b
64c
64d
64e
64f
65
65a
66
66a
81
82
83
84

【FIG. 12】



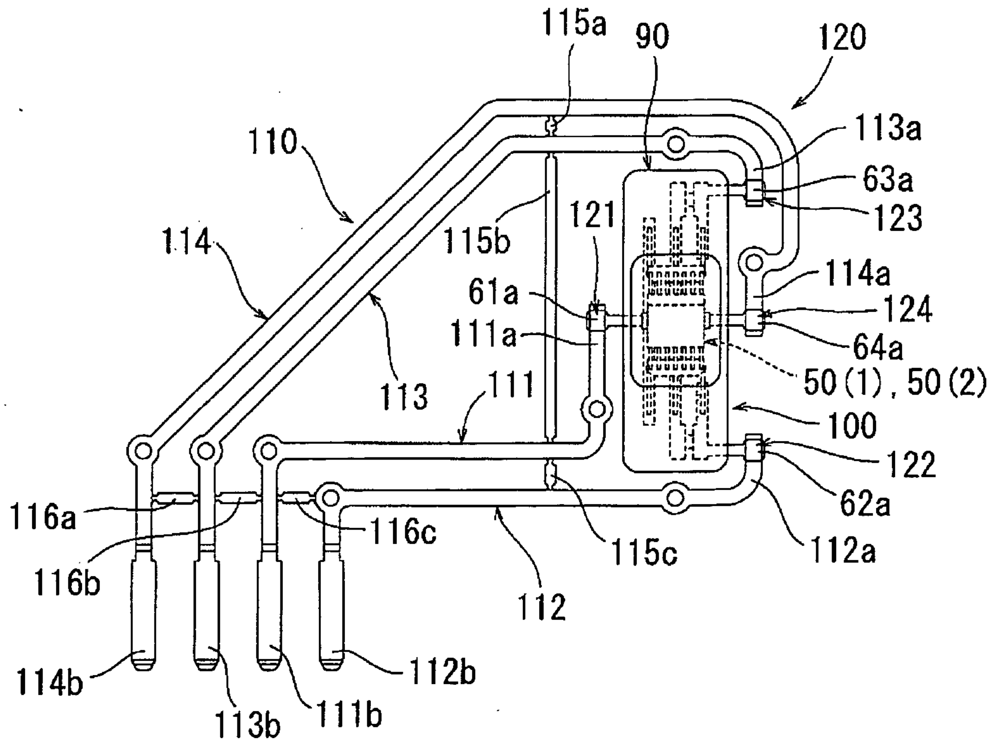
(a)
100
63
63a
64
64a
50 (1) , 50 (2)
45
62a
62
90
43
61a
61
44
(b)
100
90
91
50 (2)
50 (1)
83
63a
63
81
64a
64
82
102
62a
62
84
(c)
100
61a
61
81
82
90
50 (2)
50 (1)
83
84
63
64
62
63a
64a
62a

【FIG. 13】



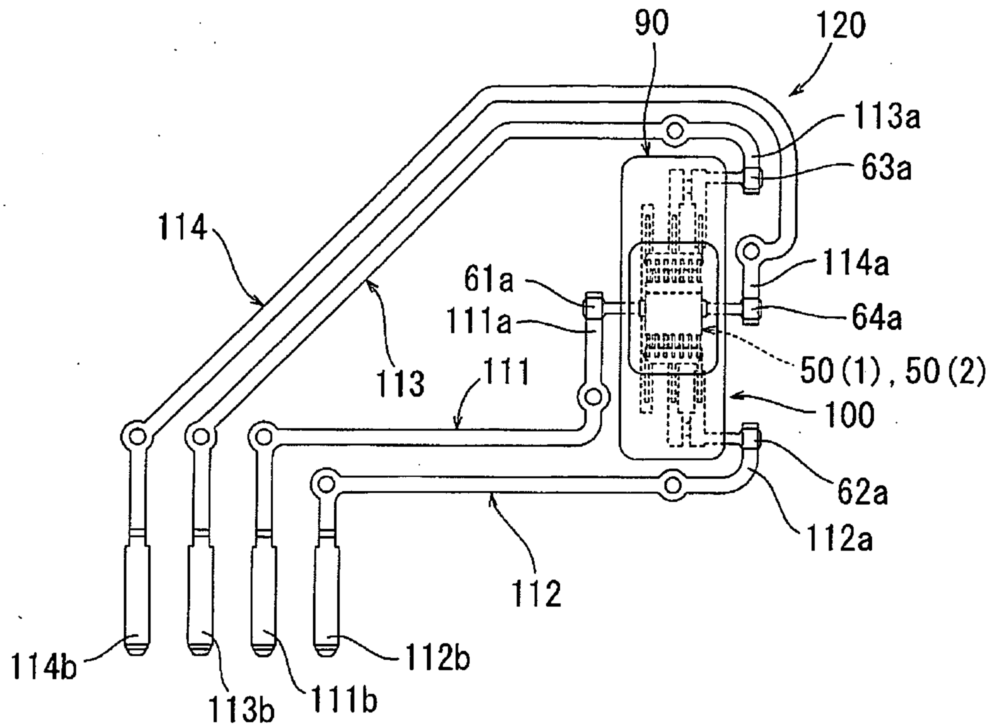
110
115a
113a
114
115b
114a
111
111a
113
112a
115c
112
114b
116a
116b
116c
112b
113b
111b

【FIG. 14】

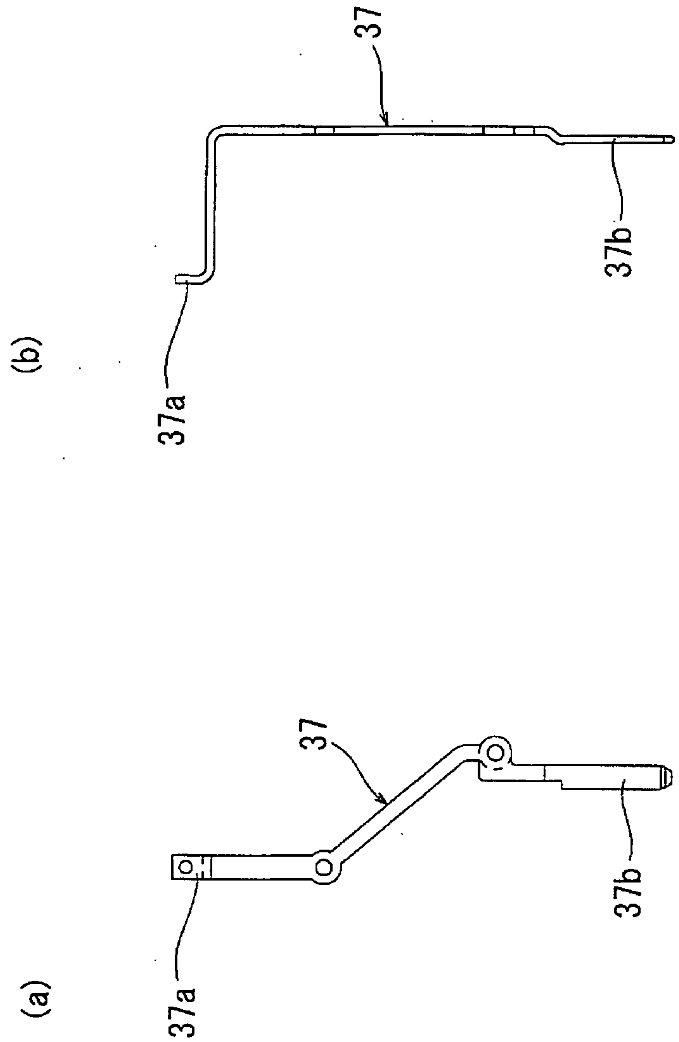


115a
90
120
110
113a
63a
123
114
115b
121
114a
61a
124
111a
64a
50(1), 50(2)
113
111
100
122
62a
116a
116c
115c
112a
116b
112
114b
112b
113b
111b

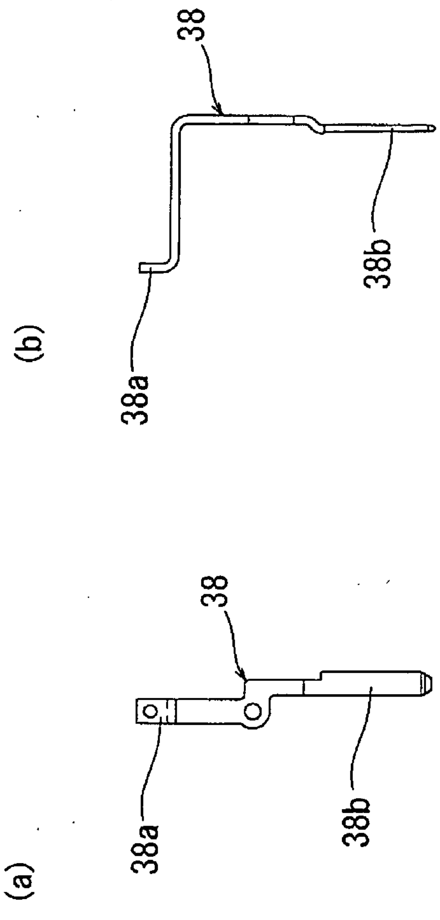
【FIG. 15】


90
120
113a
63a
114
114a
61a
111a
64a
113
111
50(1), 50(2)
100
62a
112a
112
114b
113b
111b
112b

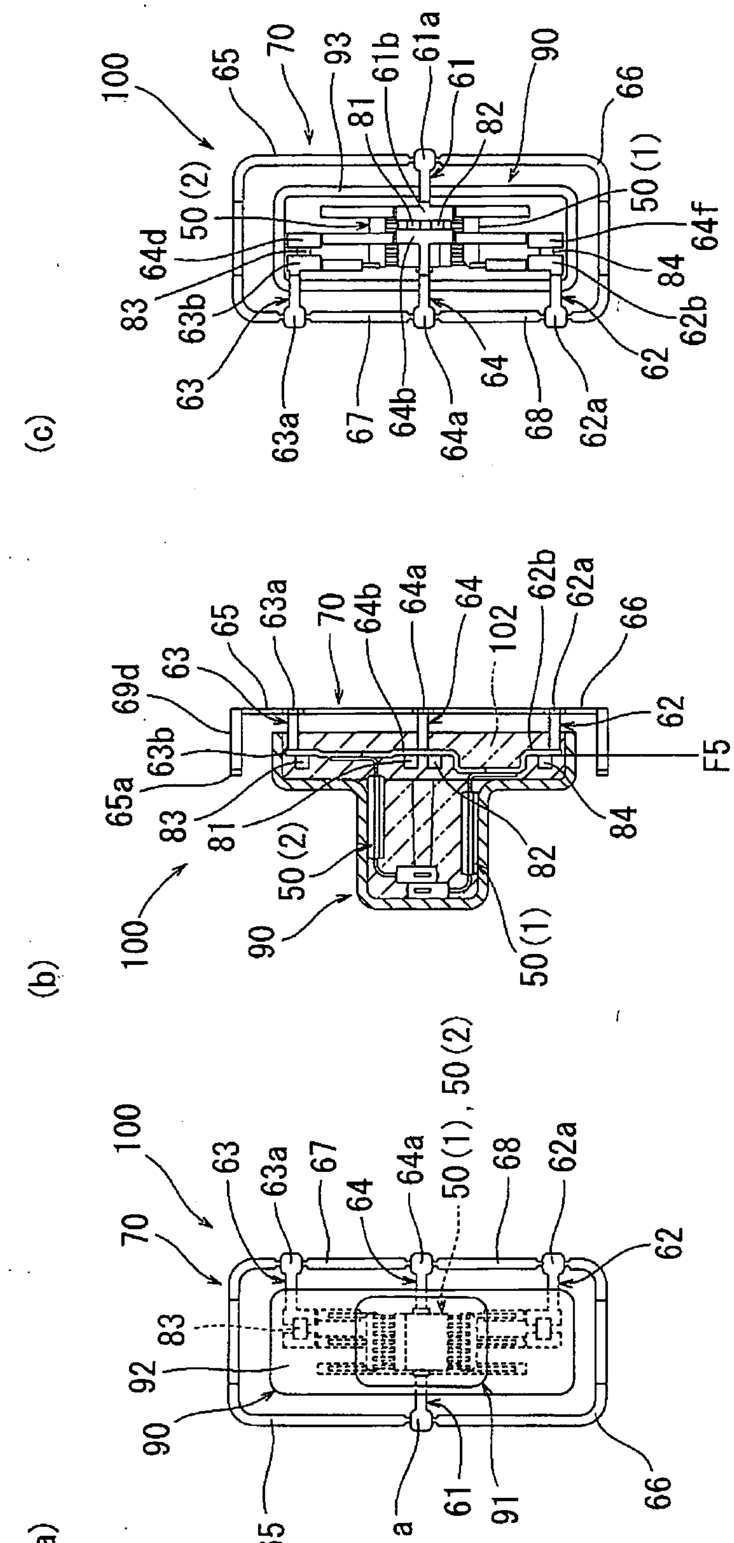
【FIG. 16】



【FIG. 17】



【FIG. 18】


(a)
(b)
(c)
100
70
65
66
67
68
61
61a
61b
62
62a
62b
63
63a
63b
64
64a
64b
64d
64f
65a
69d
81
82
83
84
90
91
92
93
102
F5
50 (1)
50 (2)
50 (1), 50 (2)